



Drainage Reports



Preliminary Drainage Report

Site 42 2.5 MG Reservoir

26906 North Pima Road,
Scottsdale, AZ 85266

Case No. 534-PA-2018

Draft for Review

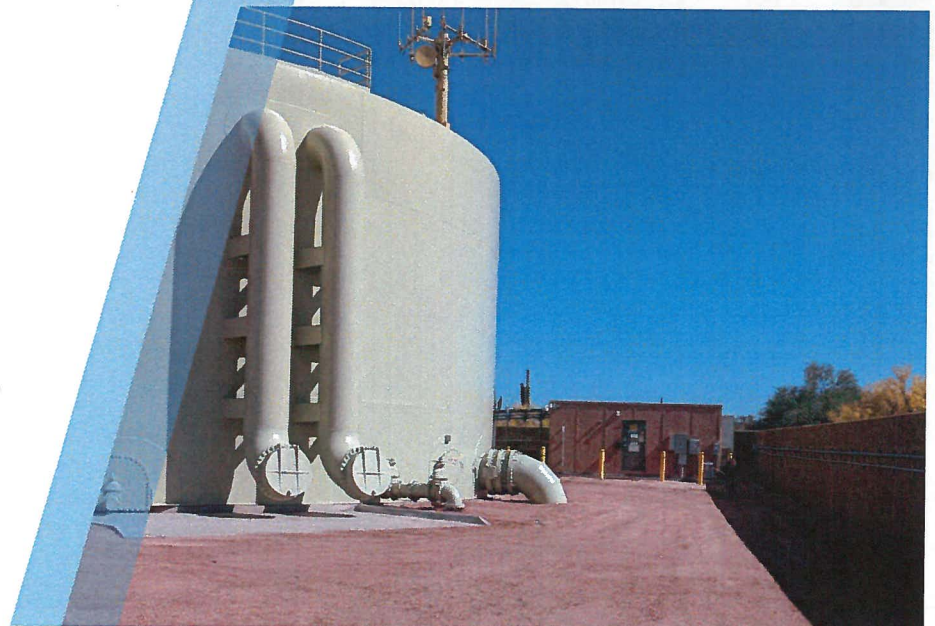
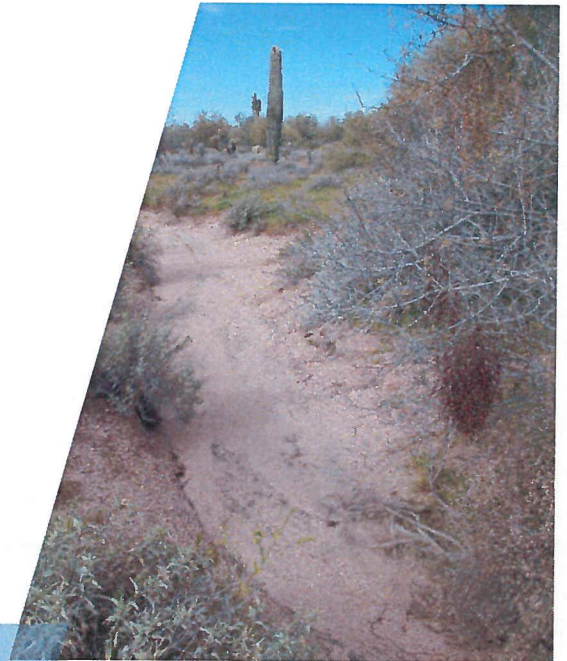




Table of Contents

1.	Introduction	1
1.1	Purpose and Objectives	1
1.2	Special Conditions	2
2.	Pre-Development Conditions	3
2.1	Existing Flow Paths	3
2.2	Analysis	3
2.2.1	Parameter Selection	4
3.	Post-Development Conditions	6
3.1	Proposed Flow Paths	6
3.2	Analysis	6
3.2.1	Parameter Selection	7
3.2.2	Retention Basin Design	8
4.	Conclusions	9

Figure Index

Figure 1.1	Site 42 Vicinity Map	2
Figure 2.1	Basin 1 Pre-Development Runoff Coefficients Justification	4
Figure 2.2	Basin 2 Pre-Development Runoff Coefficient Justification	5
Figure 2.3	Basin 3 Pre-Development Runoff Coefficients Justification	6

Table Index

Table 2.1	Basin 1 Pre-Development Runoff Coefficients for 100-Year Storm	4
Table 2.2	Basin 2 Pre-Development Runoff Coefficient for 100-Year Storm	5
Table 2.3	Basin 3 Pre-Development Runoff Coefficients for 100-Year Storm	5
Table 3.1	Basin 1 Post-Development Runoff Coefficients for 100-Year Storm	7
Table 3.2	Basin 2 Post-Development Runoff Coefficients for 100-Year Storm	7
Table 3.3	Basin 3 Post-Development Runoff Coefficient for 100-Year Storm	8
Table 3.4	Site 42 Required Storage Volume	8



Exhibit Index

Exhibit 1	Pre-Development Site Plan
Exhibit 2	Post-Development Site Plan

Appendix Index

Appendix A	Site 42 Off-Site Drainage Analysis
Appendix B	FEMA F.I.R.M. Map
Appendix C	Site 42 Proposed Grading Plan
Appendix D	Site 42 Precipitation Depths from NOAA Website



1. Introduction

Site 42 is a potable water facility owned and operated by the City of Scottsdale (City). The facility is located at 26906 North Pima Road, Scottsdale, AZ 85262. The vicinity map in Figure 1.1 depicts the site's general location.

The site provides water to the northern zones of the City's water distribution system. It consists of two booster pump stations, two above-ground water storage tanks, telecommunications equipment, and a storage yard. In addition, the facility includes a water fill station that is used for private domestic water deliveries.

The City would like to increase the site's water storage capacity to meet growth within the service area. This will be achieved by adding a new 2.5 million gallon (MG) above-ground water storage tank to the facility. The site will be expanded west to provide room for the new tank. In addition, the site's existing southern wall will be moved further south to increase the existing site's footprint. The site expansion will require a Conditional Use Permit, which will be issued by the City's Development Review Board (DRB).

Site 42 is located within a drainage area studied in the Pinnacle Peak West Area Drainage Master Study (PPW ADMS). This regional drainage study was conducted by the Flood Control District of Maricopa County (FCDMC), the City of Scottsdale, and the City of Phoenix. Specifically, the site lies close to the Upper Rawhide Wash floodplain, which is one of the washes analyzed in the study.

JE Fuller Hydrology and Geomorphology, Inc. (JE Fuller), who participated in the PPW ADMS, was hired by GHD to determine the impact of off-site drainage on the site's expansion. The findings from this off-site drainage analysis are included in Appendix A. The on-site drainage analysis for the Site 42 expansion was performed by GHD and is summarized in this report.

1.1 Purpose and Objectives

The purpose of this report is to fulfill the drainage report requirement for the City of Scottsdale's Conditional Use Permit application. The objectives of the on-site drainage analysis are:

- To identify the site's pre-development drainage flow paths and conditions,
- To identify the site's post-development drainage flow paths and conditions,
- To provide basin sizing for retaining the difference between the pre-development and the post-development runoff volume.

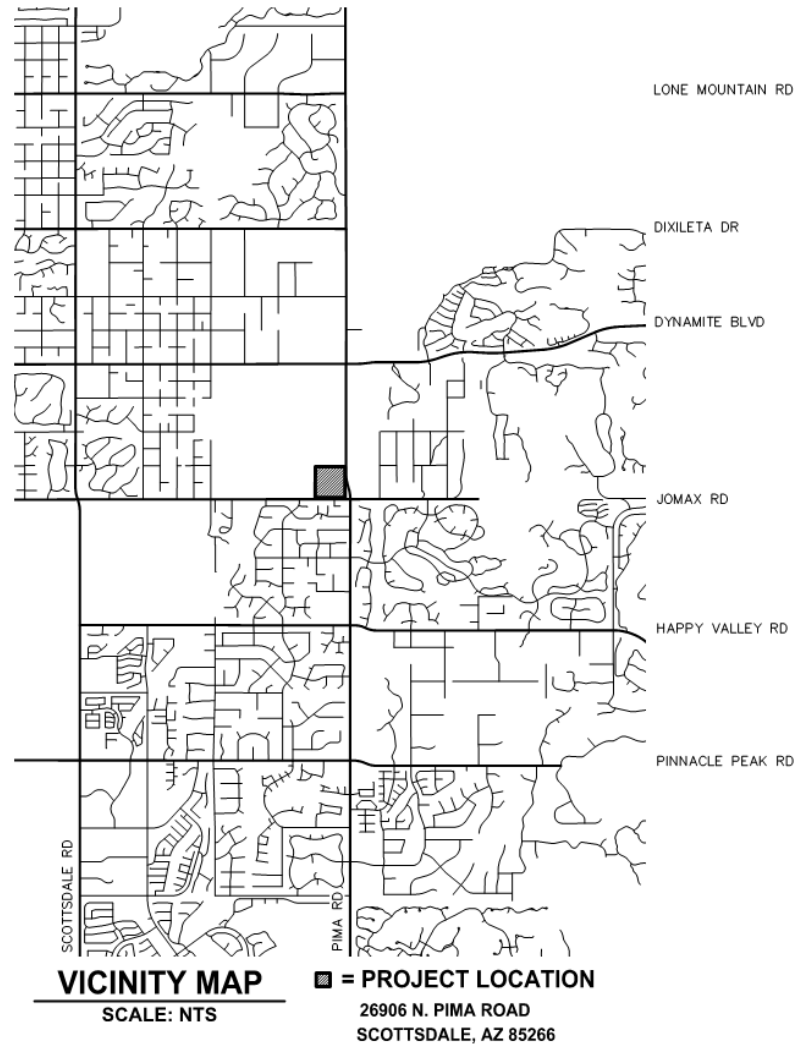
The objectives of the off-site drainage analysis are:

- To determine the flood elevation of a small wash that runs close to the proposed location of the new tank. This nearby wash is a small tributary to the Upper Rawhide Wash described above.
- To establish the required erosion hazard setback from the nearby wash.

The off-site drainage analysis is based on data developed for FCDMC as part of the PPW ADMS. The findings from the analysis can be found in Appendix A.



Figure 1.1 Site 42 Vicinity Map



1.2 Special Conditions

GHD and Richard Anderson, City of Scottsdale Stormwater Review Manager, met on February 20th, 2019. The following conditions regarding the drainage analysis for the Site 42 expansion project were agreed upon during this meeting:

- An offsite level 1 erosion hazard setback analysis, with a minimum 20-ft setback, is required to determine the flood limits of a small wash just west of the new tank location.
- Data from the PPW ADMS can be utilized for the off-site drainage analysis with a minimum 1.3 safety factor.
- The project will be required to retain the difference between the pre-development and post-development runoff volume. A basic volume calculation can be applied to determine the



difference between the pre and post-development runoff. Time of concentration is not required to be incorporated since the site covers such a small area.

- Flow paths should be described but flowrates do not have to be quantified since the site covers such a small area. The existing site will continue to drain through wall openings to the land southwest of the property.
- It is preferred to drain the retention basin through a bleed pipe. Percolation can be considered if it is not feasible to install a bleed pipe.
- The site will be required to retain the first flush if the disturbance is one acre or more.
- The on-site retention basin shall not be oversized for sediment.
- Operations and Maintenance Plans are not required for the drainage report.
- The Stormwater Pollution Prevention Plan and Notice of Intent to Discharge will be prepared by the Contractor.

2. Pre-Development Conditions

Site 42 is located in a natural desert environment. It is surrounded by State Trust Land and nearby residential neighborhoods. The site was recently rezoned and currently has a R1-43 (single family residential) zoning classification.

According to the Flood Insurance Rate Map (F.I.R.M.) number 04013C1310L dated October 16, 2013, Site 42 is located within an area classified as "Other Areas". This means that the area is outside of the 0.2% annual chance floodplain or is an area in which flood hazards are undetermined, but possible. F.I.R.M. number 04013C130L is included in Appendix B.

It should be noted that Site 42 sits just outside of an area classified as "Zone AO". This classification refers to special flood hazard areas subject to inundation by the 1% annual chance flood with depths between 1 to 3 feet. However, the off-site analysis in Appendix A provides a more localized floodplain delineation based on data developed for FCDMC as part of the PPW ADMS.

2.1 Existing Flow Paths

The existing grading of the site consists of gentle slopes (<3%) from the northeast to the southwest. On-site runoff exits the site through existing wall openings on the site's west and south walls. After exiting the site, the on-site runoff discharges into surrounding natural desert land. Natural drainage flow paths around the site carry the runoff southwest and eventually connect to the Rawhide Wash downstream. Exhibit 1 depicts the existing flow paths for Site 42.

2.2 Analysis

Three drainage basins were identified for the on-site drainage analysis. Basin 1 includes the existing site. Basin 2 includes the land where the proposed improvements will be built. Basin 3 includes the land just south of Site 42, which will be added to the site once the wall is relocated. The on-site drainage basins are depicted on Exhibit 1.

2.2.1 Parameter Selection

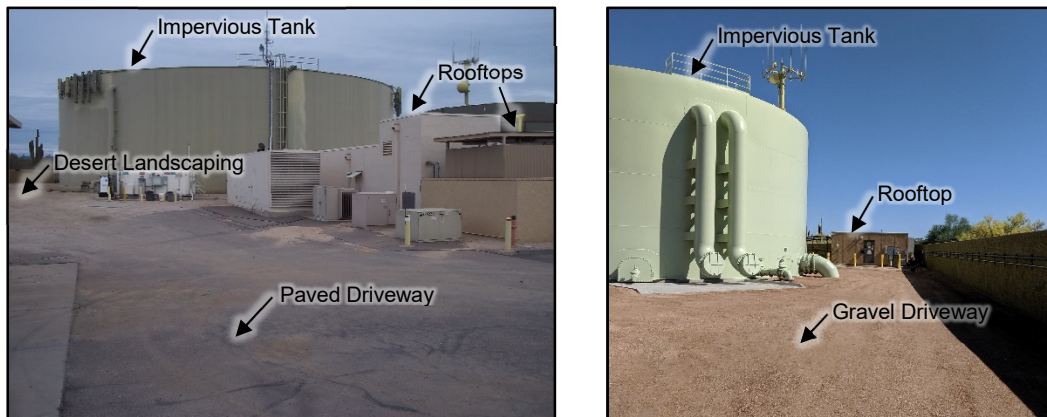
Site 42 consists of multiple land covers, including a paved driveway, building rooftops, decomposed granite ground cover, etc. Table 2.1 summarizes the pre-development runoff coefficients and areas determined for each land cover type in Basin 1. The runoff coefficients were taken from Figure 4-1.5 from the City of Scottsdale Design Standards and Policies Manual (DSPM), with the exception of any impervious surfaces. A runoff coefficient of 1.0 was assumed for impervious surfaces. In addition, a 100-year storm frequency was assumed.

Table 2.1 Basin 1 Pre-Development Runoff Coefficients for 100-Year Storm

Land Use	Runoff Coefficient, C	Area, A (ft ²)	C*A (ft ²)
Paved streets, parking lots (concrete or asphalt), roofs, driveways, etc.	0.95	39,095	37,140
Gravel floodways and shoulders	0.82	29,109	23,869
Undisturbed natural desert or desert landscaping (no impervious weed barrier)	0.45	22,296	10,033
Impervious Surfaces	1.00	18,556	18,556
	Sum =	109,056	89,598

Figure 2.1 includes two photos taken at Site 42 that justify the selected land covers for Basin 1.

Figure 2.1 Basin 1 Pre-Development Runoff Coefficients Justification



A composite pre-development runoff coefficient was determined for Basin 1 using the information summarized in Table 2.1:

$$C_{1 \text{ pre}} = \Sigma(C \cdot A) / \Sigma(A) = (89,598) / (109,056) = 0.82$$

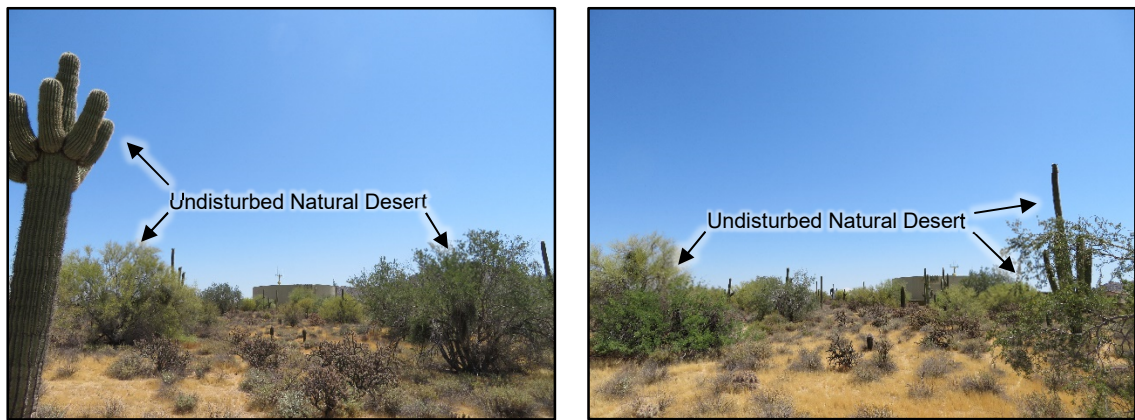
The land on which the new tank will be built is currently undisturbed natural desert. Using Figure 4-1.5 from the City's DSPM and assuming a 100-year storm frequency, the pre-development runoff coefficient for Basin 2 ($C_{2 \text{ pre}}$) was determined to be **0.45**. This information is summarized in Table 2.2.

Table 2.2 Basin 2 Pre-Development Runoff Coefficient for 100-Year Storm

Land Use	Runoff Coefficient, C	Area, A (ft ²)
Undisturbed natural desert or desert landscaping (no impervious weed barrier)	0.45	28,207

Figure 2.2 includes two photos taken outside of Site 42 where the new improvements will be built. The photos support the selected land cover for Basin 2.

Figure 2.2 Basin 2 Pre-Development Runoff Coefficient Justification



The land in Basin 3 consists of undisturbed natural desert and a gravel driveway. Table 2.3 summarizes the pre-development runoff coefficients and areas for these land covers. The runoff coefficients were taken from Figure 4-1.5 from DSPM assuming a 100-year storm frequency.

Table 2.3 Basin 3 Pre-Development Runoff Coefficients for 100-Year Storm

Land Use	Runoff Coefficient, C	Area, A (ft ²)	C*A (ft ²)
Gravel floodways and shoulders	0.82	7,391	6,061
Undisturbed natural desert or desert landscaping (no impervious weed barrier)	0.45	5,703	2,566
Sum =		13,094	8,627

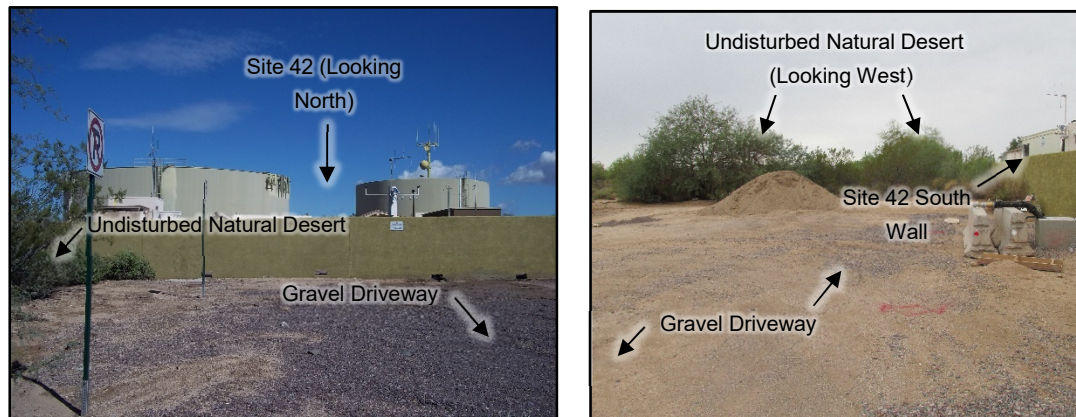
Figure 2.3 includes two photos just south of Site 42 that justify the selected land covers for Basin 3.

A composite pre-development runoff coefficient was determined for Basin 3 using the information summarized in Table 2.3:

$$C_{3 \text{ pre}} = \Sigma(C \cdot A) / \Sigma(A) = (8,627) / (13,094) = 0.66$$



Figure 2.3 Basin 3 Pre-Development Runoff Coefficients Justification



3. Post-Development Conditions

3.1 Proposed Flow Paths

The flow paths at Site 42 will generally remain the same. On-site runoff will drain towards the southwest corner of the site. Stormwater will exit the site through wall openings along the new south wall. In addition, some stormwater will leave the site through a new gate located on the south wall. A portion of the runoff will be retained outside of the site's southwest corner. Further discussion on proposed retention is provided in Section 3.2.2. The rest of the runoff will follow existing flow paths to the southwest and discharge into the Rawhide Wash downstream. Exhibit 2 provides an overview of the post-development flow paths.

Proposed grading around the site's new tank will direct runoff towards the new south wall. In addition, wall openings will be added to a portion of the site's new west wall. Proposed grading at the site's northwest corner will direct runoff towards these new wall openings. Once runoff exits the site at these northwest openings, it will be carried southwest by natural drainage flow paths to eventually discharge into the Rawhide Wash. The proposed grading plan has been included in Appendix C.

3.2 Analysis

The same on-site basins analyzed in Section 2.2 were considered for the post-development analysis. Disturbances to Basin 1 will be limited. Most of the existing site's west wall will be removed and a portion of the new tank will encroach into the existing site. Basin 2 will be completely modified since it will house the new tank. The land cover around the tank will include a stabilized soil driveway and decomposed granite. A concrete channel will also be installed at the tank's drain. The natural desert land cover for Basin 3 will be removed and replaced with gravel to allow vehicles to drive on top of it. The post-development basins are depicted in Exhibit 2.



3.2.1 Parameter Selection

Table 3.1 summarizes the post-development runoff coefficients and areas determined for each land cover type in Basin 1. The runoff coefficients were taken from Figure 4-1.5 from the City's DSPM, with the exception of any impervious surfaces. A runoff coefficient of 1.0 was assumed for impervious surfaces. In addition, a 100-year storm frequency was assumed.

Table 3.1 Basin 1 Post-Development Runoff Coefficients for 100-Year Storm

Land Use	Runoff Coefficient, C	Area, A (ft ²)	C*A (ft ²)
Paved streets, parking lots (concrete or asphalt), roofs, driveways, etc.	0.95	37,984	36,085
Gravel floodways and shoulders	0.82	31,371	25,724
Undisturbed natural desert or desert landscaping (no impervious weed barrier)	0.45	19,443	8,749
Impervious Surfaces	1.00	20,258	20,258
	Sum =	109,056	90,816

Using the information from Table 3.1, a post-development composite runoff coefficient was determined for Basin 1:

$$C_{1 \text{ post}} = \Sigma(C*A) / \Sigma(A) = (90,816)/(109,056) = 0.83$$

Using Figure 4-1.5 from the City's DSPM and assuming a 100-year storm frequency, the post-development runoff coefficients for Basin 2 were also determined. This information is summarized in Table 3.2.

Table 3.2 Basin 2 Post-Development Runoff Coefficients for 100-Year Storm

Land Use	Runoff Coefficient, C	Area, A (ft ²)	C*A (ft ²)
Paved streets, parking lots (concrete or asphalt), roofs, driveways, etc.	0.95	8,466	8,043
Undisturbed natural desert or desert landscaping (no impervious weed barrier)	0.45	9,959	4,481
Impervious Surfaces	1.00	9,783	9,783
	Sum =	28,207	22,307

Using the information from Table 3.2, a post-development composite runoff coefficient was determined for Basin 2:

$$C_{2 \text{ post}} = \Sigma(C*A) / \Sigma(A) = (22,307)/(28,207) = 0.79$$

Finally, the post-development runoff coefficient for Basin 3 ($C_{3 \text{ post}}$) was determined to be **0.82** based on Figure 4-1.5 from the City's DSPM and assuming a 100-year storm frequency. This information is summarized in Table 3.3.

**Table 3.3 Basin 3 Post-Development Runoff Coefficient for 100-Year Storm**

Land Use	Runoff Coefficient, C	Area, A (ft ²)
Gravel floodways and shoulders	0.82	13,094

3.2.2 Retention Basin Design

The difference between the site's pre-development and post-development runoff volume will be retained in a new retention basin outside of the site's southwest corner. This stormwater storage volume was calculated using the formula provided in Section 4-1.201.C.1.b from the City's DSPM:

$$V_r = \Delta C \cdot (R/12) \cdot A$$

Where,

V_r = Required storage volume in cubic feet

R = Precipitation amount = the depth in inches of the 100-year, 2-hour rainfall, from figure in Appendix 4-1C or the NOAA website for the site location

A = Area in square feet of total disturbed area attributable to the development

ΔC = the increase in the weighted average runoff coefficient over disturbed area ($C_{\text{post}} - C_{\text{pre}}$)

Table 3.4 summarizes the required storage volumes for each basin. The precipitation depth for a 100-year, 2-hour storm was obtained from the NOAA website based on the Site 42 location. This information is included in Appendix D.

Table 3.4 Site 42 Required Storage Volume

Basin	C_{pre}	C_{post}	R , in	A , ft ²	V_r , ft ³
1	0.82	0.83	2.55	109,056	232
2	0.45	0.79	2.55	28,207	2,038
3	0.66	0.82	2.55	13,094	445
				Sum =	2,715

The proposed retention basin will provide a storage volume of about 6,875 ft³, which exceeds the total required storage volume (2,715 ft³). The retention basin will have side slopes of 4:1 (run-to-rise). The total depth of the retention basin will be 4', but it is expected that the 100-year water depth will not rise above 3'.

Installing a bleed pipe in the retention basin to detain runoff is not feasible due to the minimal elevation relief outside of the site's southwest corner. The bleed pipe would have to extend well outside of the property's boundaries to achieve an acceptable slope across the existing elevation relief.

Runoff will be retained and allowed to percolate into the ground. Results from a percolation test will be included in the final drainage report. According to the United States Department of Agriculture



(USDA) National Resources Conservation Service (NCRS) Web Soil Survey (WSS), the soil at Site 42 is considered to be Vado Gravelly Sandy Loam. The percolation rate for this type of soil ranges between 1.98 in/hr to 5.95 in/hr.

Assuming a worst case percolation rate of 1.98 in/hr and a depth of 3' in the retention basin, it is expected that the drain time will be about 18 hours. Using a safety factor of 2 to account for reductions in basin floor percolation rates over time, the drain time will still meet the 36 hour requirement per Section 4-1.201.B.2.c in the City's DSPM. It should be noted that this drain time was calculated assuming a worst case percolation rate for this soil. It is expected that the drain time will be reduced once a percolation test is performed.

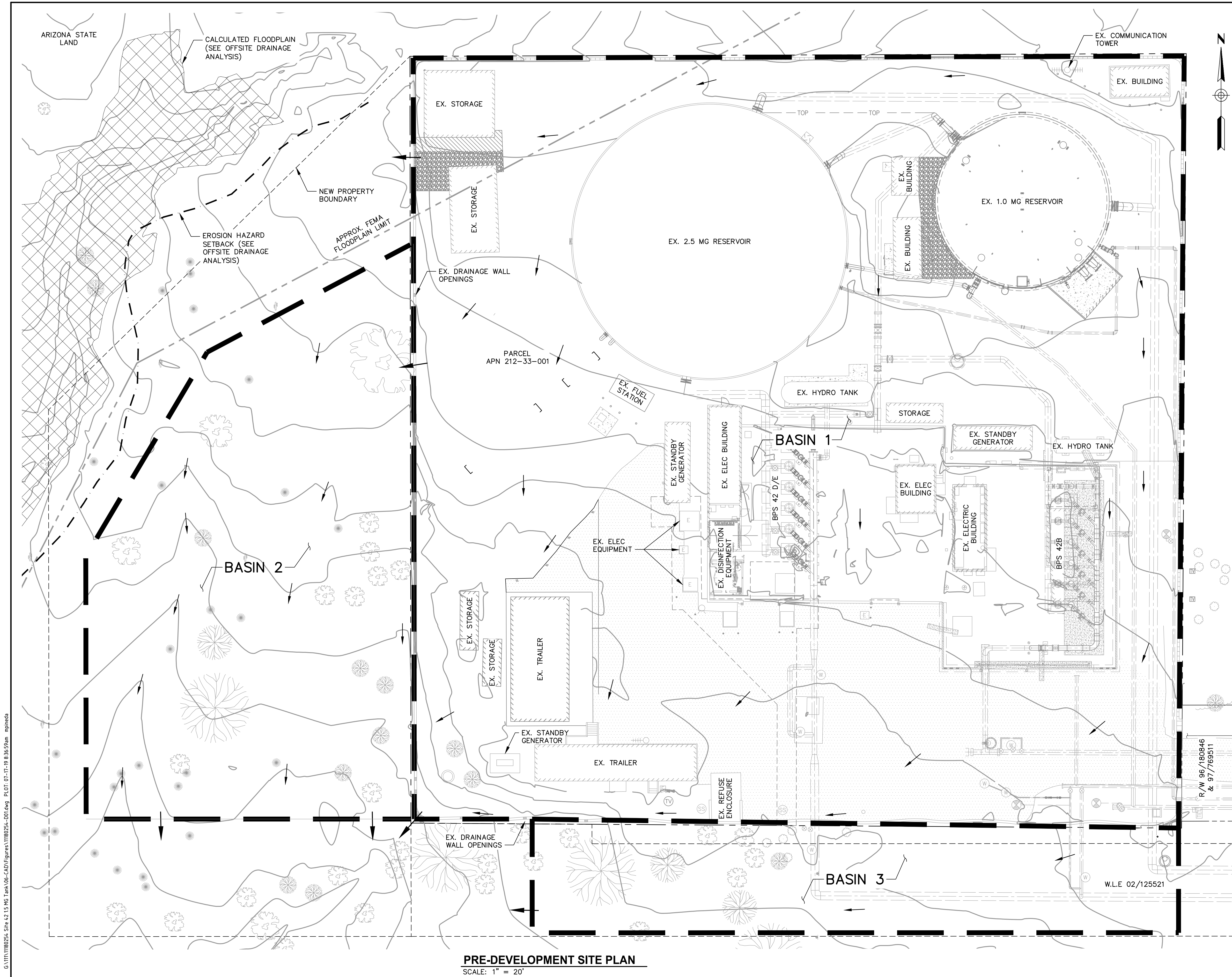
The disturbed area for this project is 0.95 acres. Since it is less than one acre, the improvements are not likely to contribute storm water contaminants to the City's municipal separate storm sewer system or waters of the U.S. Therefore, the retention of the first flush volume was not considered for this project.

4. Conclusions

Based on the on-site and off-site drainage analyses performed at Site 42, the following conclusions were made:

1. The delineation of the floodplain near Site 42 was recently updated in the PPW ADMS, a regional drainage study conducted by the FCDMC. The offsite analysis for Site 42 was based on this updated delineation.
2. Using data from the PPW ADMS, a level 1 erosion hazard setback analysis was performed. A minimum setback from the flood limits of a small tributary just west of the new tank location was determined. All proposed structures will be located outside of this established setback.
3. Existing site drainage outfall locations will be maintained.
4. A new retention basin will retain the difference between the pre-development runoff volume and the post-development runoff volume. Since it is not feasible to install a bleed pipe in the retention basin, all retained stormwater will be percolated into the ground.
5. The area of disturbance for this project will be 0.95 acres. Therefore, it is not required to retain the site's first flush volume.

G:\11180254_Site 42 15 MG Tank\6-CAD\Figures\1180254-001.dwg PLOT 01-17-19 8:36:59am mpmcda



PRE-DEVELOPMENT SITE PLAN
SCALE: 1" = 20'

GHD GHD Inc.
4747 North 22nd Street Suite 200
Phoenix Arizona 85016 USA
T 1 602 216 7200 F 1 602 216 7201 W www.ghd.com

NOTES

BASIN 1

PAVEMENT ROOFS: 0.90 AC @ 0.95
GRAVEL: 0.67 AC @ 0.82
DESERT LANDSCAPING: 0.51 AC @ 0.45
IMPERVIOUS LANDSCAPING: 0.43 AC @ 1.00
TOTAL: 2.50 AC @ 0.82

BASIN 2

NATURAL DESERT LAND: 0.65 AC @ 0.45

BASIN 3

GRAVEL: 0.17 AC @ 0.82
DESERT LANDSCAPING: 0.13 AC @ 0.45
TOTAL: 0.30 AC @ 0.66

LEGEND

→ = FLOW PATH
□ = BASIN BOUNDARIES

0 10 20 30 40'
SCALE 1"=20' AT ORIGINAL SIZE

**30% SUBMITTAL
FOR AGENCY
REVIEW ONLY**

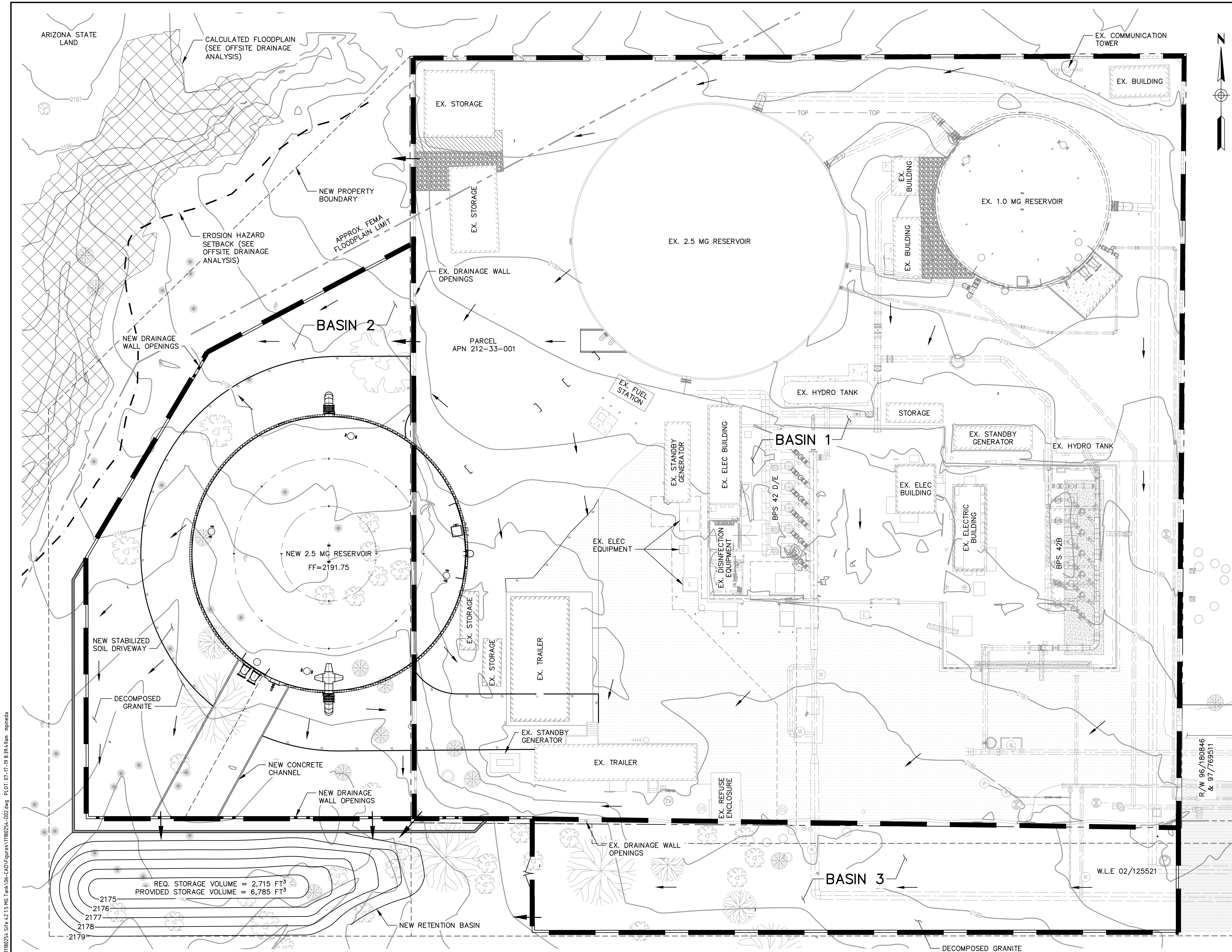
Contact Arizona 811 at least two full
working days before you begin excavation
ARIZONA 811
Call 811 or click Arizona811.com

DATE	REVISION	BY
ENGINEER		
PUBLIC WORKS		
WATER RESOURCES DEPARTMENT		
9388 E. SAN SALVADOR DR. SCOTTSDALE, AZ 85258		

SHEET TITLE				
EXHIBIT 1				
PRE-DEVELOPMENT SITE PLAN				
PROJECT TITLE				
SITE 42				
25 MG RESERVOIR				
SCALE	DESIGNED	DATE	BID NO.	SHT.
HORIZ. AS	WDR	JULY 2019		D1
VERT. NOTED	DRAWN	AS-BUILT	PROJECT NO.	1 OF 2
	DCG		WFO2A	

XREFS: 11180254-XC_BASE; 11180254-XC_TOPO; Seal-WDR; 11180254-XG_TBLK; 11180254-XM_BASE Fuel Station - Leech Field; Site 42 Site Pima Rd; Site 42 Site Plan; Site 42 Southeast area;

G:\111\1180254_Site 42 15 MG Tank\06-CADD\Figures\1180254-002.dwg PLOT: 07-11-19 8:39:45am mpineda



POST-DEVELOPMENT SITE PLAN
SCALE: 1" = 20'



GHD Inc.
4747 North 22nd Street Suite 200
Phoenix Arizona 85016 USA
T 1 602 216 7200 F 1 602 216 7201 W www.ghd.com

NOTES

BASIN 1

PAVEMENT ROOFS: 0.87 AC @ 0.95
GRAVEL: 0.72 AC @ 0.82
DESERT LANDSCAPING: 0.45 AC @ 0.45
IMPERVIOUS LANDSCAPING: 0.47 AC @ 1.00
TOTAL: 2.50 AC @ 0.83

BASIN 2

PAVEMENT ROOFS: 0.19 AC @ 0.95
NATURAL DESERT LAND: 0.23 AC @ 0.45
IMPERVIOUS LANDSCAPING: 0.22 AC @ 1.00
TOTAL: 0.65 AC @ 0.79

BASIN 3

GRAVEL: 0.30 @ 0.82

LEGEND

- = FLOW PATH
□ = BASIN BOUNDARIES

0 10 20 30 40'
SCALE 1"=20' AT ORIGINAL SIZE

**30% SUBMITTAL
FOR AGENCY
REVIEW ONLY**



DATE	REVISION	BY
ENGINEER		
		PUBLIC WORKS WATER RESOURCES DEPARTMENT 9388 E. SAN SALVADOR DR. SCOTTSDALE, AZ 85258

SHEET TITLE				
EXHIBIT 2 POST-DEVELOPMENT SITE PLAN				
PROJECT TITLE				
SITE 42 25 MG RESERVOIR				
SCALE	DESIGNED	DATE	BID NO.	SHT.
HORIZ. AS	WDR	JULY 2019		D2
VERT. NOTED	DWG	AS-BUILT	PROJECT NO.	2 OF 2
			WF02A	

XREFS: 11180254-XC_BASE; 11180254-XC_TOPO; Seal-WDR; 11180254-XG_TBLK; 11180254-XM_BASE Fuel Station - Leech Field; Site 42 Site Pima Rd; Site 42 Site Plan; Site 42 Southeast area;



Appendix A

Site 42 Off-Site Drainage Analysis

Memorandum

DATE: 4/3/2019

TO: Bill Roberts
GHD

FROM: Jon Ahern, PE, CFM
JE Fuller Hydrology and Geomorphology, Inc.

RE: **City of Scottsdale Site 42, 2.5MG Tank
EHZ Assessment**



Introduction

This memorandum summarizes the findings of a research and off-site hydraulics/floodplain evaluation to support the new 2.5 MG water tank expansion for Site 42, City of Scottsdale. The site is located at the north west corner of Scottsdale and Jomax Roads.

This erosion hazard analysis and report consists of the following elements:

- Data Collection
- Field Observations and Geomorphic Interpretation
- Hydraulic Modeling
- Recommendations & Conclusions

Data Collection

JE Fuller has conducted research or has contacted the individuals or entities listed in Table 1 to obtain information regarding historical drainage report and relevant information pertaining to off-site hydrology/hydraulics and available documentation regarding the adjacent wash.

Table 1 Relevant Historical Documents

Individual or Entity	Document Name	Summary of Findings
Flood Control District of Maricopa County	Pinnacle Peak West (PPW) Area Drainage Master Study.	FLO2D Study and model results.
GHD	11180254-XC_BASE.dwg	AutoCAD drawing file of proposed site improvements Site development plans.
	11180254-XC_TOPO.dwg	
	11180254-XM_BASE.dwg	Overall site plan
	11180254-XC_TOPO - Expansion (2-20-19).pdf	
	1 - 2.5 MG East Figure.pdf	Miscellaneous site figures
	Channels.pdf	
	FIRM.pdf	
	Flo-2D Flows.pdf	
	Flo-2D hydrograph.pdf	

7-UP-2019
8/2/2019

Field Observations and Geomorphic Interpretation

A field investigation of the new 2.5 MG water tank expansion for Site 42 (Site 42) was conducted by JE Fuller staff on March 11, 2019. The investigation consisted of walking the wash upstream and downstream of the project site, observing/recording existing conditions, interpreting the geomorphology of the wash, and collecting photographs (Figure 1).

The wash channel bed within the vicinity of Site 42 can be described as sandy bottom between two and 8 feet in width. The bed material is coarse sand and appears to be uniform within the wash. The banks are between one and two feet in height with a mild back slope. The wash slopes were stable with minimal evidence of lateral instability¹.

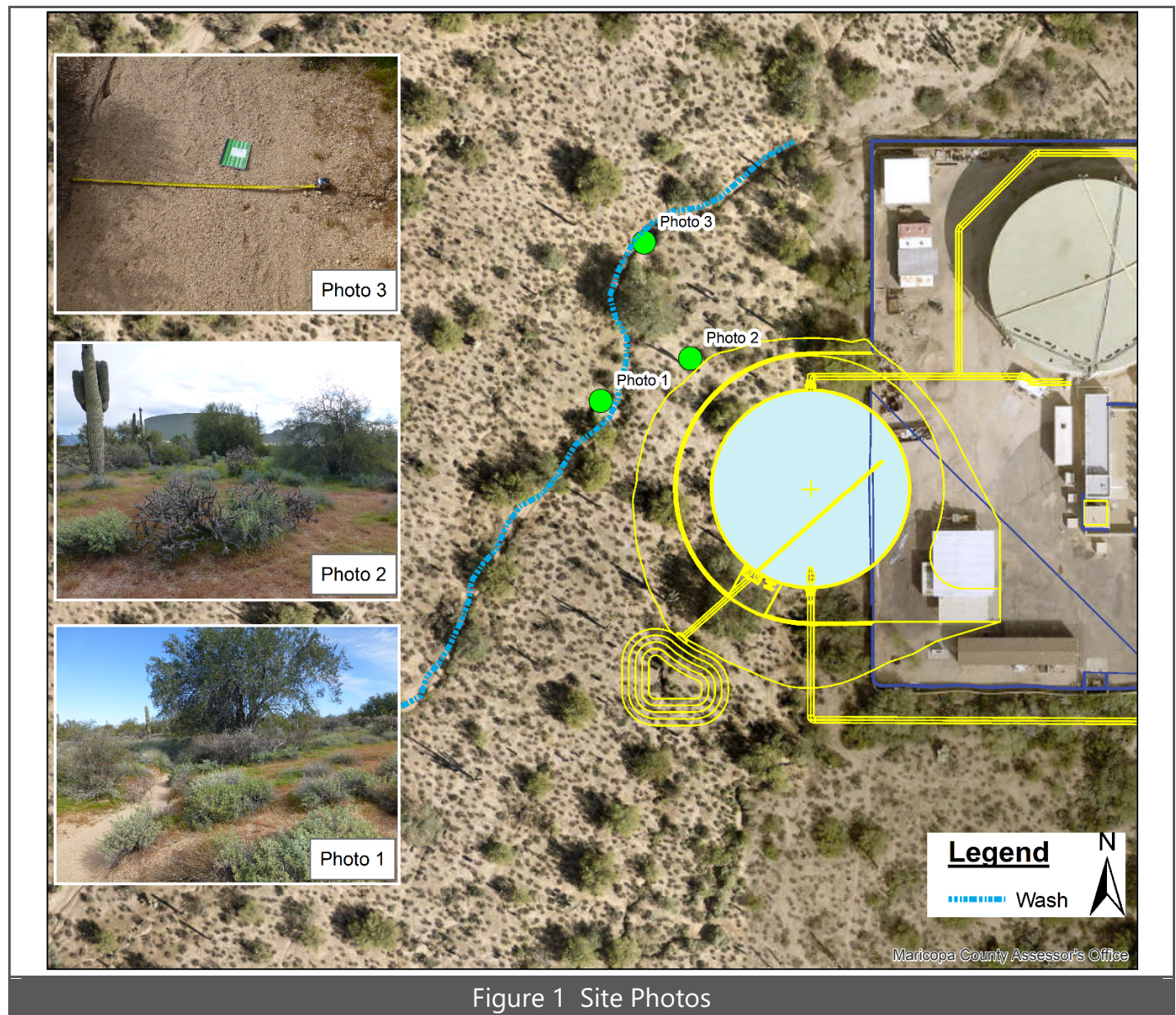
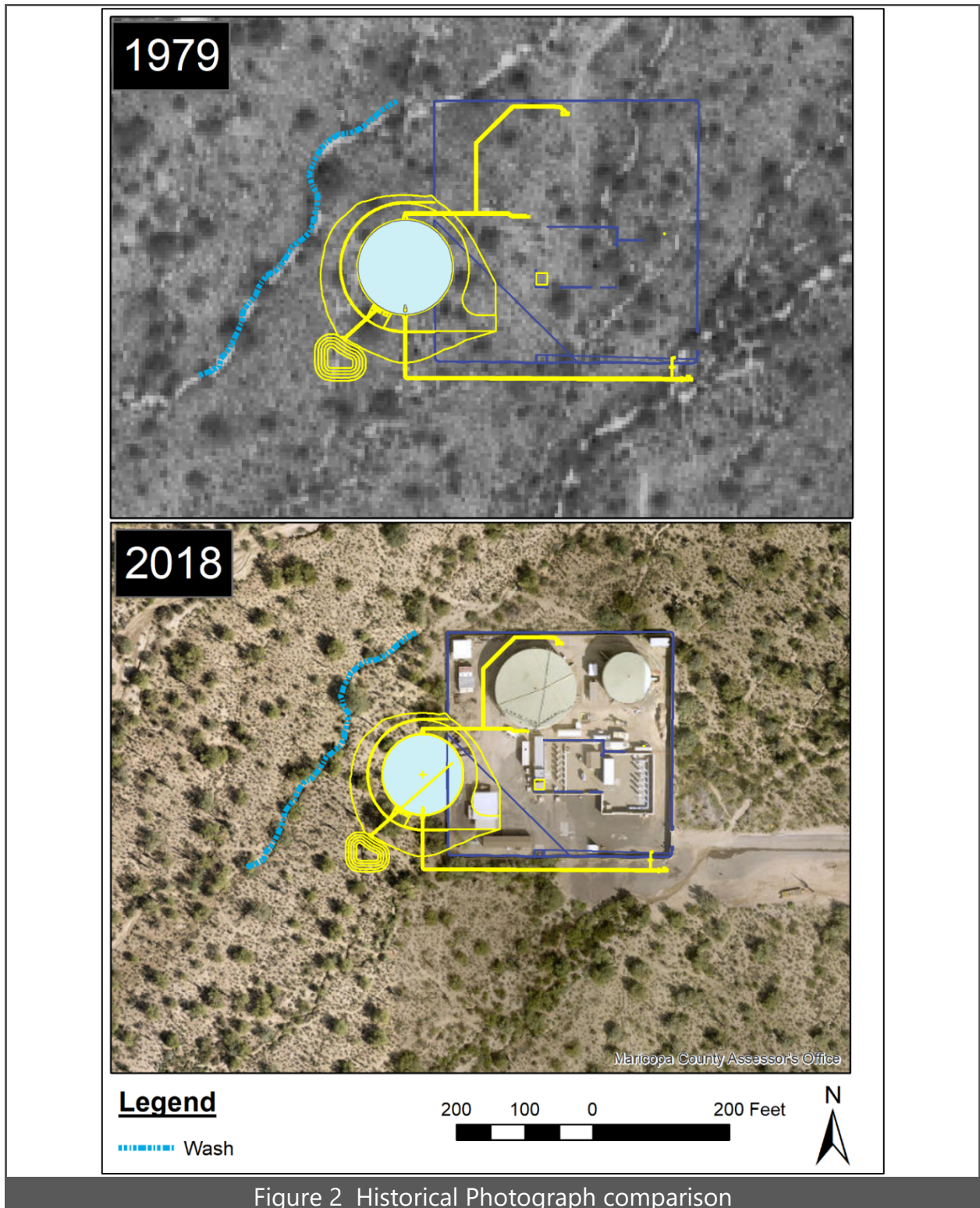


Figure 1 Site Photos

¹ Evidence of lateral instability may include cutbanks and vertical banks, exposed vegetation roots, immature bank vegetation, etc.

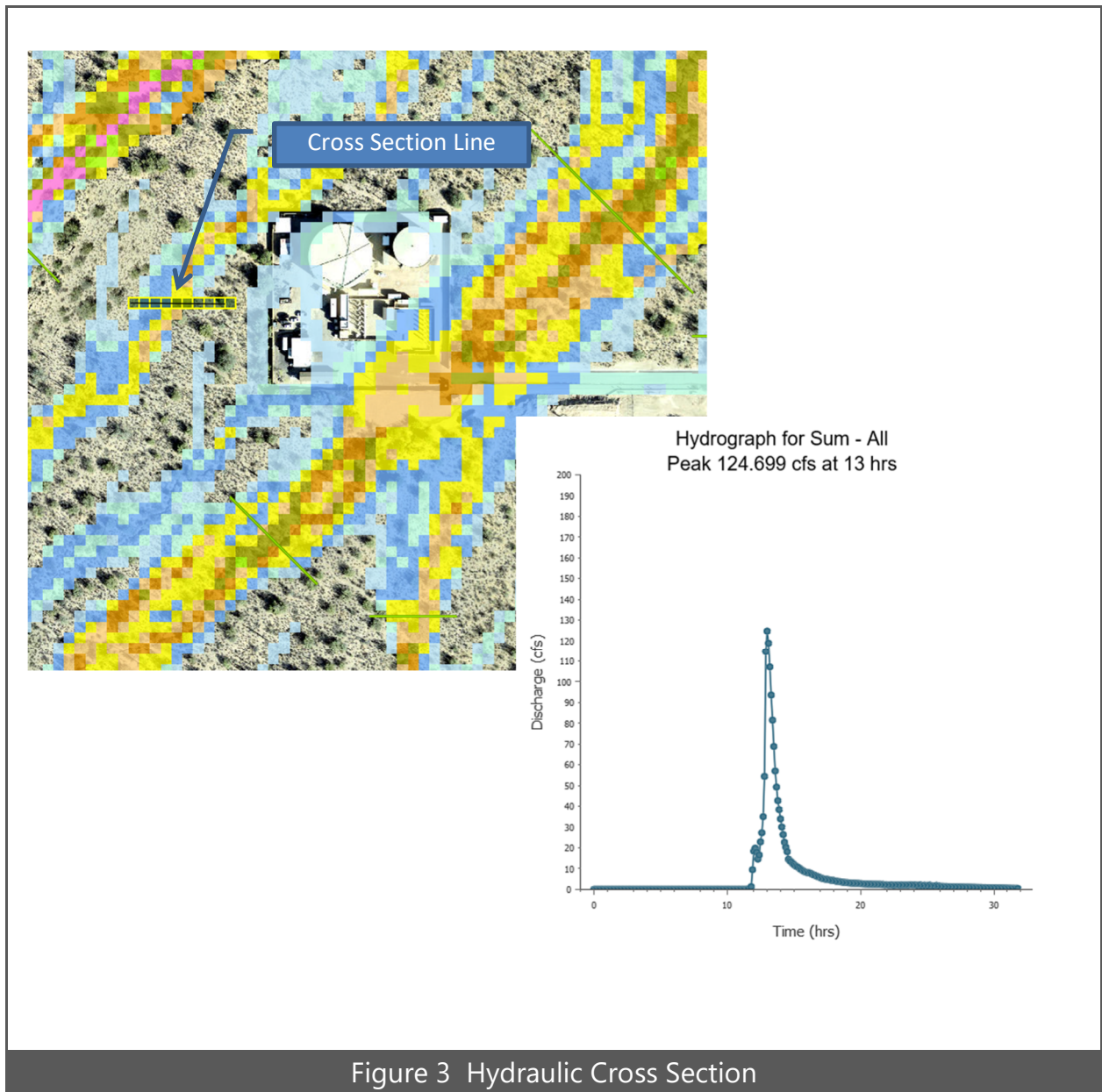
An historical 1979 aerial photograph was obtained and semi-rectified using ArcGIS 10.7 software tools. A comparison of the 1979 aerial photograph with modern aerial photography (2018) indicates the channel has been laterally stable for at least the past 40 years (Figure 2).



Hydraulic Modeling

The 100-year, 24-hour storm event discharge for the unnamed wash at Site 42 were determined using the Flood Control District of Maricopa County's (FCDMC) online FLO2D tool. A cross section line was created in the vicinity of Site 42 and the tool used to develop a hydrograph and a peak discharge from FLO2D study date. The data was developed for FCDMC as part of the Pinnacle Peak West Area Drainage Master Study, 2014.

A hydraulic model was developed using United States Army Corps of Engineers HEC-RAS (v5.06) model and provided to GHD for inclusion with the site design drawings. Hydraulic model is discussed further in the appendix.



Erosion Hazard Setback

The erosion hazard setback for Site 42 was computed using the Level 1 procedures outlined in the ADWR State Standard SS5-96 – *State Standard for Watercourse System Sediment Balance*. The Level 1 analysis requires the drainage area of the watershed contributing to the site of interest, and the 100-year peak discharge. The Level 1 analysis is valid for watercourses with a drainage area less than 30 square miles. Although the flow for the wash under study is from a breakout of the main wash to the west, the equation is applicable. The Level 1 analysis applies one of the following equations to compute the erosion setback distance:

Setback Eqn #1 = $1.0(Q_{100})^{0.5}$ – straight channel reaches or minor curvature

Setback Eqn #2 = $2.5(Q_{100})^{0.5}$ – obvious channel curvature or channel bend

The channel reach within Site 42 is nearly straight (see Figure 2), therefore Setback Eqn #1 is applicable.

$$\text{Setback} = 1.0(125)^{0.5} = 11.2 \text{ feet}$$

Recommendations & Conclusions

The results of the Level 1 Erosion Hazard Setback analysis are 11.2 feet measured from the top of the channel banks, however a minimum setback of 20 feet is recommended. Given that the channel has been historically stable and does not exhibit evidence of lateral migration trends, 20 feet is a conservative erosion setback. It is recommended that the improvements associated with the 2.5 MG water tank expansion at Site 42 be located outside of this setback.

APPENDIX

Hydraulic Model Development

In addition to the Erosion Hazard setback provided above, a simple hydraulic model was prepared using the United States Army Corps of Engineers HEC-RAS (v5.06) modeling program to develop a floodplain for the small wash adjacent to the site. Floodplain Limits were provided to GHD to include on site development plans. Floodplain (Figure 4) and cross section plots are provided below.

The following data was used to develop the HEC-RAS model;

- Elevation data provided by GHD.
- Manning's n-values determined from field visit.
 - Main Channel = 0.035
 - Overbanks = 0.045
- Boundary Conditions
 - Normal depth using channel slope = 0.0233
- Contraction and Expansion coefficient of 0.1/0.3 respectively.
- Two profiles run
 - Profile 1 = 1.3 times 100-year or 165 cfs (Displayed on Figure 4)
 - Profile 2 = 100-year determined from online FLO2D tool

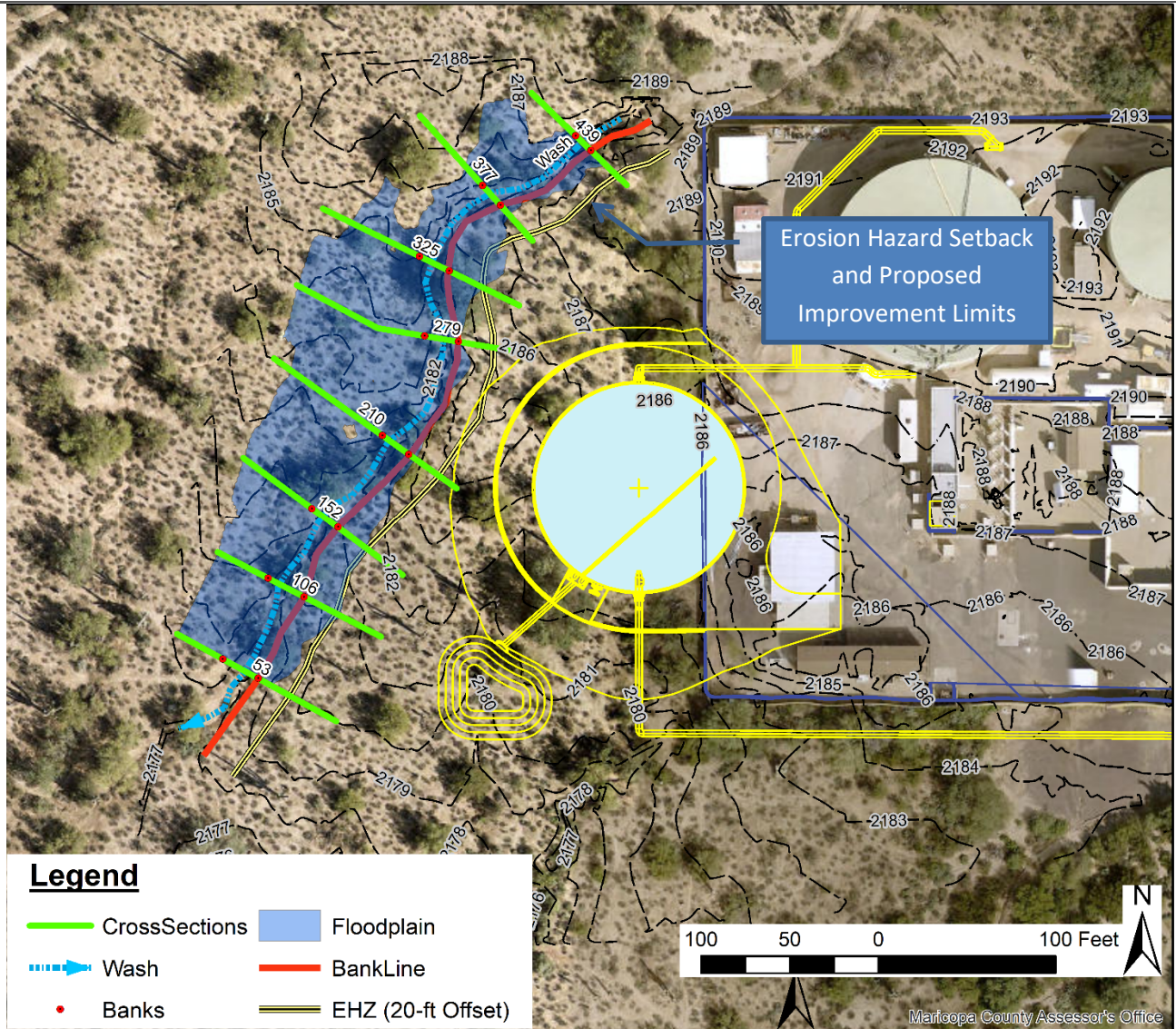
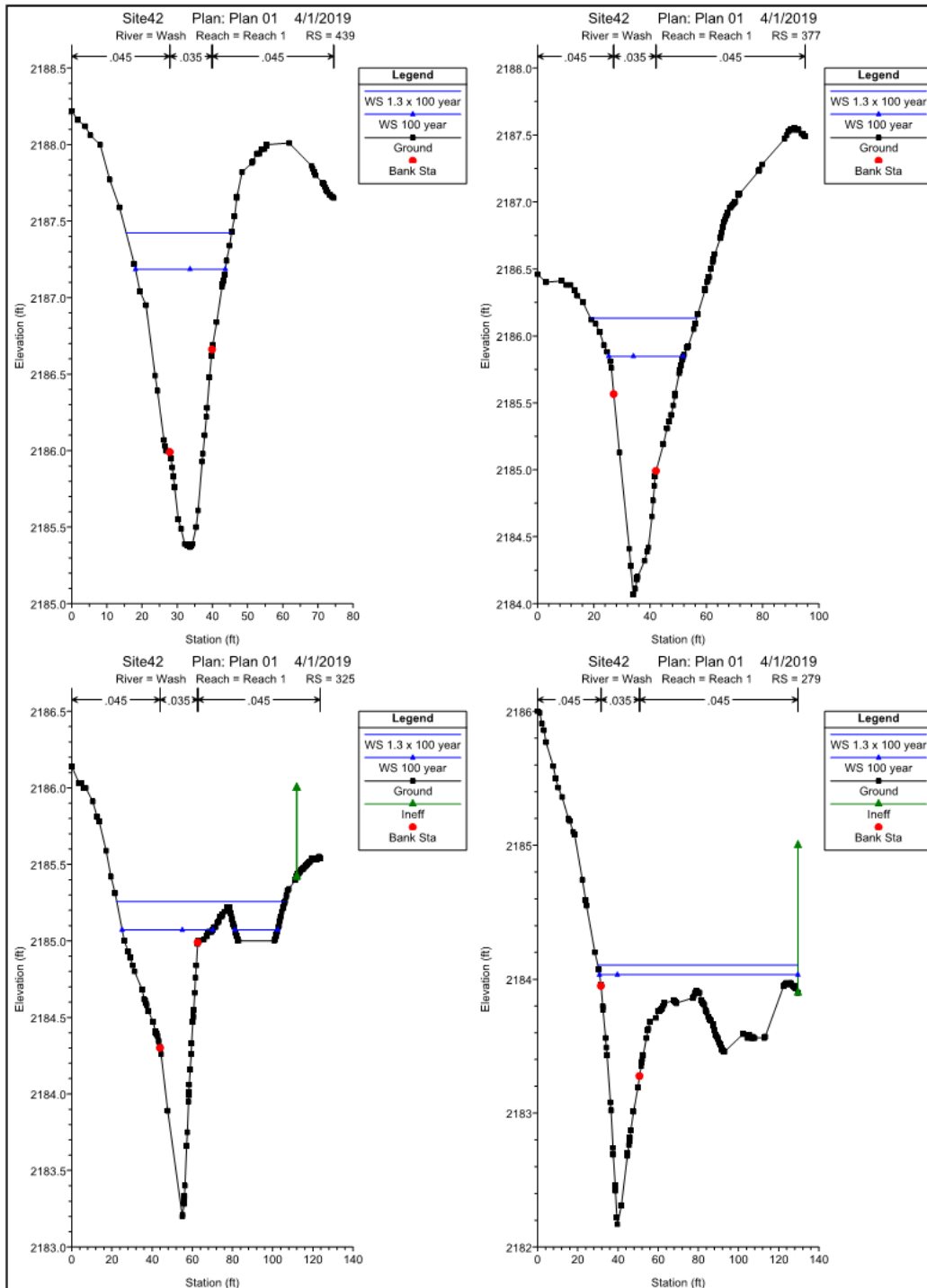
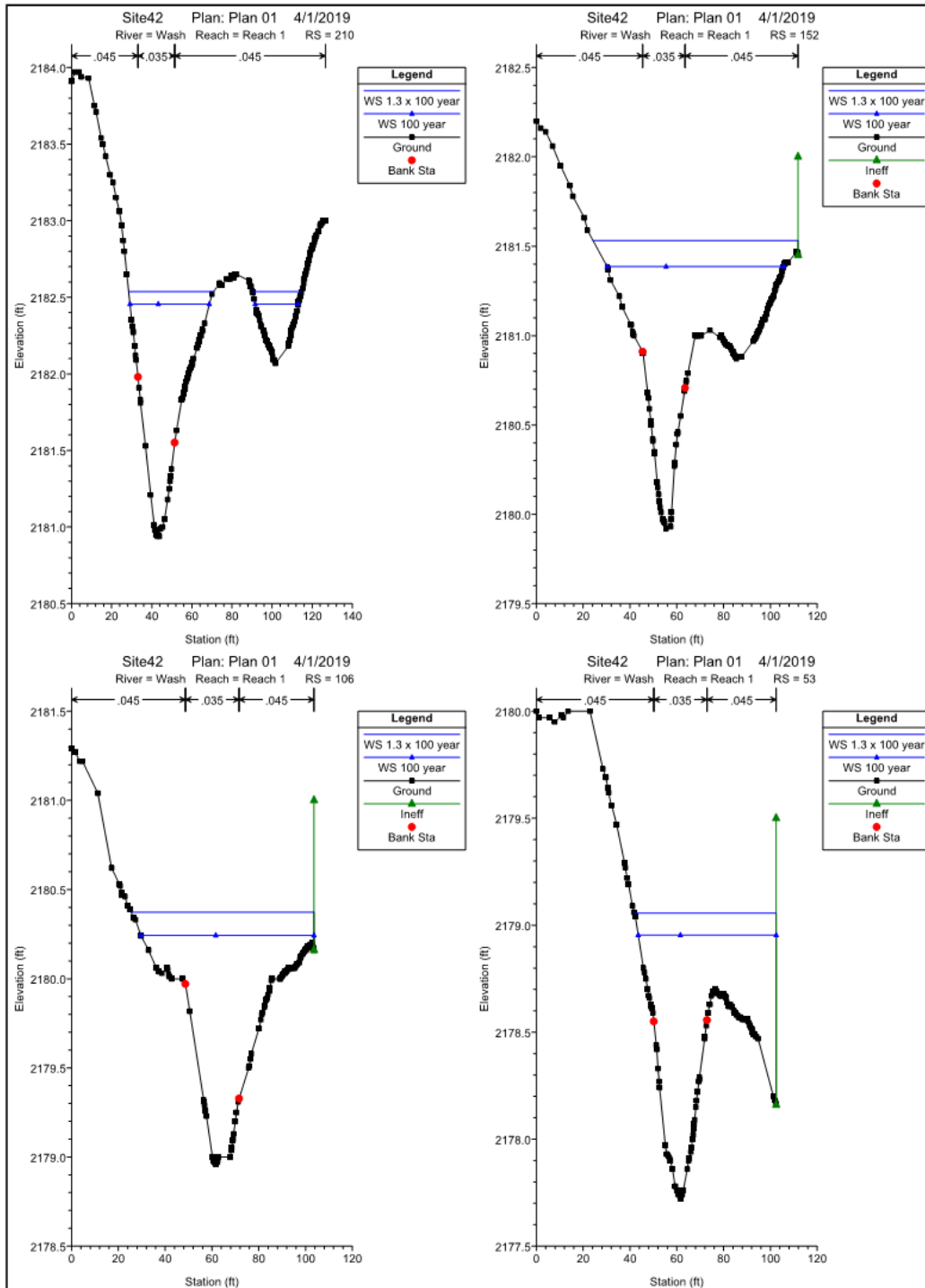


Figure 4 Hydraulic Cross Section and Floodplain Results



1





Appendix B

FEMA F.I.R.M. Map

NOTES TO USERS

This map is for use in administering the Nation Flood Insurance Program. It does not necessarily identify all areas subject to flooding, particularly from local drainage sources of small size. The community map repository should be consulted for possible updated or additional flood hazard information.

To obtain more detailed information in areas where **Base Flood Elevations** (BFEs) and/or **floodways** have been determined, users are encouraged to consult the Flood Profiles and Floodway Data and/or Summary of Stillwater Elevations tables contained within the Flood Insurance Study (FIS) report that accompanies this FIRM. Users should be aware that BFEs shown on the FIRM represent rounded whole-foot elevations. These BFEs are intended for flood insurance rating purposes only and should not be used as the sole source of flood elevation information. Accordingly, flood elevation data presented in the FIS report should be utilized in conjunction with the FIRM for purposes of construction and/or floodplain management.

Coastal Base Flood Elevations shown on this map apply only landward of 0.0' North American Vertical Datum of 1988 (NAVD 88). Users of this FIRM should be aware that coastal flood elevations are also provided in the Summary of Stillwater Elevations table in the Flood Insurance Study report for this jurisdiction. Elevations shown in the Summary of Stillwater Elevations table should be used for construction and/or floodplain management purposes when they are higher than the elevations shown on this FIRM.

Boundaries of the **floodways** were computed at cross sections and interpolated between cross sections. The floodways were based on hydraulic considerations with regard to requirements of the National Flood Insurance Program. Floodway widths and other pertinent floodway data are provided in the Flood Insurance Study report for this jurisdiction.

Certain areas not in Special Flood Hazard Areas may be protected by **flood control structures**. Refer to Section 2.4 "Flood Protection Measures" of the Flood Insurance Study report for information on flood control structures for this jurisdiction.

The **projection** used in the preparation of this map was Arizona State Plane Central zone (FIPSZONE 0202). The **horizontal datum** was NAD 83 HARN, GRS1980 spheroid. Differences in datum, spheroid, projection or State Plane zones used in the production of FIRMs for adjacent jurisdictions may result in slight positional differences in map features across jurisdiction boundaries. These differences do not affect the accuracy of this FIRM.

Flood elevations on this map are referenced to the North American Vertical Datum of 1988 (NAVD 88). These flood elevations must be compared to structure and ground elevations referenced to the same **vertical datum**. Map users wishing to obtain flood elevations referenced to the National Geodetic Vertical Datum of 1929 (NGVD 29) may use the following Maricopa County website application: <http://www.fcd.maricopa.gov/Maps/gismaps/apps/gdacs/application/index.cfm>

This web tool allows users to obtain point-specific datum conversion values by zooming in and hovering over a VERTCON checkbox on the layers menu on the left side of the screen. The VERTCON grid referenced in this web application was also used to convert existing flood elevations from NGVD 29 to NAVD 88.

To obtain current elevation, description, and/or location information for National Geodetic Survey bench marks shown on this map, please contact the Information Services Branch of the National Geodetic Survey at (301) 713-3242, or visit its website at <http://www.ngs.noaa.gov>. To obtain information about Geodetic Denatification and Cadastral Survey bench marks produced by the Maricopa County Department of Transportation, please visit the Flood Control District of Maricopa County website at <http://www.fcd.maricopa.gov/Maps/gismaps/apps/gdacs/application/index.cfm>.

Base map information shown on this FIRM was derived from multiple sources. Aerial imagery was provided in digital format by the Maricopa County Department of Public Works. Flood Control District. The imagery is dated October 2009 to November 2009. Additional National Agricultural Imagery Program (NAIP) imagery was provided by the Arizona State Land Department (ALRS) and is dated 2007. The coordinate system used for the production of the digital FIRM is State Plane Arizona Central NAD83 HARN, International Feet.

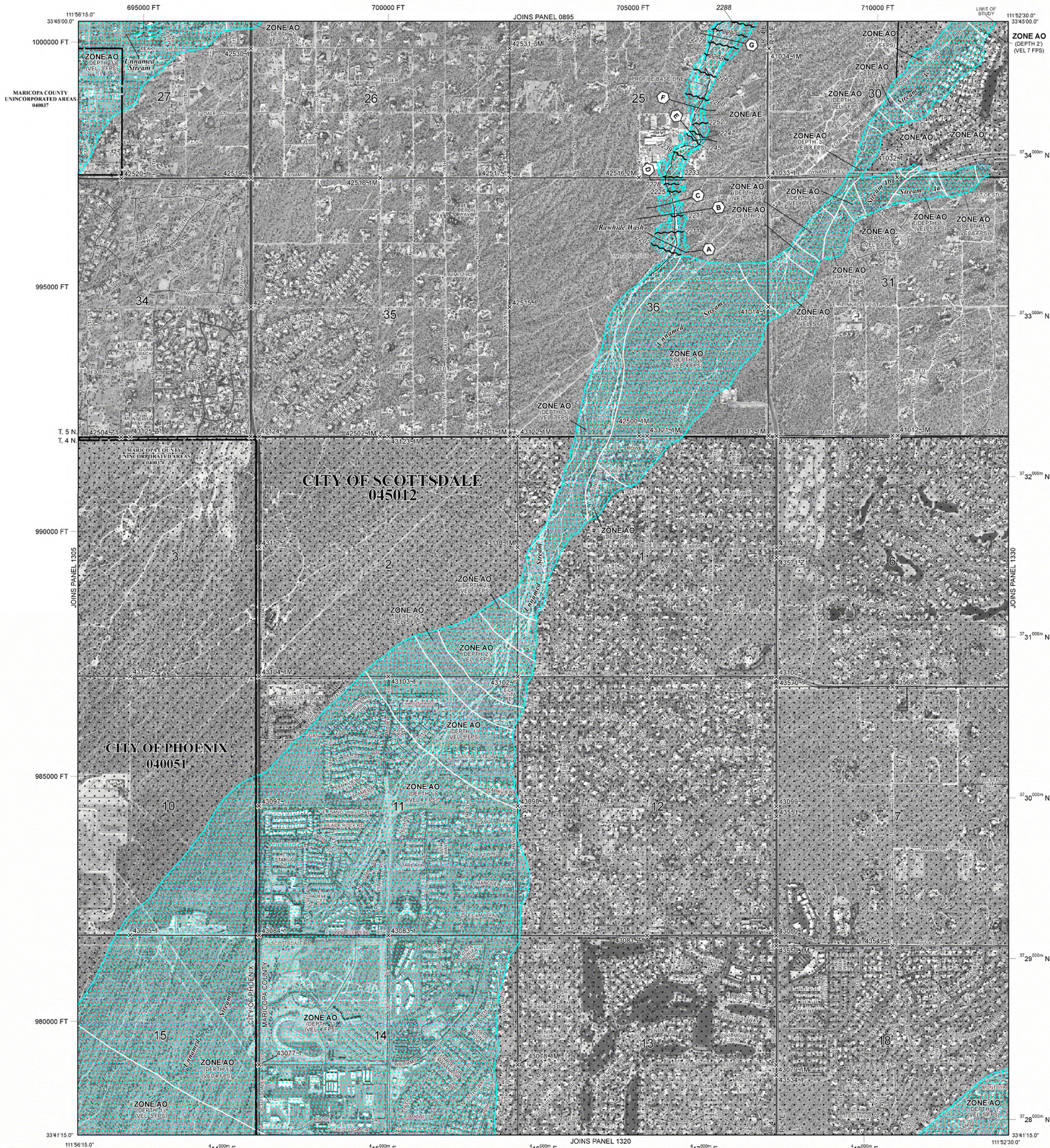
The **profile base line** depicted on this map represents the hydraulic modeling baselines that match flood profiles in the FIS report. As a result of improved topographic data, the profile base line, in some cases, may deviate significantly from the channel centerline or appear outside the SFHA.

Corporate limits shown on this map are based on the best data available at the time of publication. Because changes due to annexations or de-annexations may have occurred after this map was published, map users should contact appropriate community officials to verify current corporate limit locations.

Please refer to the separately printed **Map Index** for an overview map of the county showing the layout of map panels, community map repository addresses, and a Listing of Communities table containing National Flood Insurance Program dates for each community, as well as a listing of the panels on which each community is located.

For information on available products associated with this FIRM, visit the **FEMA Map Service Center (MSC)** website at <http://msc.fema.gov>. Available products may include previously issued Letters of Map Change, a Flood Insurance Study Report, or digital versions of this map. Many of these products can be ordered or obtained directly from the MSC website.

If you have **questions about this map**, how to order products, or the National Flood Insurance Program in general, please call the **FEMA Map Information oXchange (FMIX)** at 1-877-FEMA MAP (1-877-336-2627) or visit the FEMA website at <http://www.fema.gov/>.



LEGEND

- SPECIAL FLOOD HAZARD AREAS (SFHAs) SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD**
- The 1% annual chance flood (100-year flood), also known as the base flood, is the flood that has a 1% chance of being equaled or exceeded in any given year. The Special Flood Hazard Area is the area subject to flooding by the 1% annual chance flood. Areas of Special Flood Hazard include Zones A, AE, AH, AO, AR, A99, V and VE. The Base Flood Elevation is the water-surface elevation of the 1% annual chance flood.
- ZONE A**
No Base Flood Elevations determined.
- ZONE AE**
Base Flood Elevations determined.
- ZONE AH**
Flood depths of 1 to 3 feet (usually areas of ponding); Base Flood Elevations determined.
- ZONE AO**
Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities also determined.
- ZONE AR**
Special Flood Hazard Area formerly protected from the 1% annual chance flood by a flood control system that was subsequently decertified. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood.
- ZONE A99**
Area to be protected from 1% annual chance flood by a Federal flood protection system under construction; no Base Flood Elevations determined.
- ZONE V**
Coastal flood zone with velocity hazard (wave action); no Base Flood Elevations determined.
- ZONE VE**
Coastal flood zone with velocity hazard (wave action); Base Flood Elevations determined.
- FLOODWAY AREAS IN ZONE AE**
- The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without substantial increases in flood heights.
- OTHER FLOOD AREAS**
- ZONE X**
Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance flood.
- OTHER AREAS**
- ZONE X**
Areas determined to be outside the 0.2% annual chance floodplain.
- ZONE D**
Areas in which flood hazards are undetermined, but possible.
- COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS**
- OTHERWISE PROTECTED AREAS (OPAs)**
- CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas.
- 1% annual chance floodplain boundary
0.2% annual chance floodplain boundary
Floodway boundary
Zone D boundary
CBRS and OPA boundary
Boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths or flood velocities.
- 513 (EL. 987)
Base Flood Elevation line and value; elevation in feet*
Base Flood Elevation value where uniform within zone; elevation in feet*
- * Referenced to the North American Vertical Datum of 1988 (NAVD 88)
- A A Cross section line
- 23 23 Transsect line
- 97°07'30", 32°22'30"
Geographic coordinates referenced to the North American Datum of 1983 (NAD 83)
- 47°50'00"N
1000-meter Universal Transverse Mercator grid ticks, zone 12
- 6000000 M
5000-foot grid ticks: Arizona State Plane coordinate system, central zone (FIPSZONE 0202), Transverse Mercator
- DX5510
Bench mark (see explanation in Notes to Users section of this FIRM panel)
- M1.5
River Mile
- MAP REPOSITORIES
Refer to Map Repositories list on Map Index
- EFFECTIVE DATE OF COUNTYWIDE FLOOD INSURANCE RATE MAP
April 15, 1988
- EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL
December 31, 1993 - July 23, 2001 September 30, 2005
October 16, 2013 - to add floodway, to incorporate previously issued letters of map revision, to add roads and road names, to advance suffix, to change base flood elevations, to change floodway, to add special flood hazard areas, to add base flood elevation, and to update corporate limits.
- For community map revision history prior to countywide mapping, refer to the Community Map History table located in the Flood Insurance Study report for this jurisdiction.
- To determine if flood insurance is available in this community, contact your insurance agent or call the National Flood Insurance Program at 1-800-638-6620.

NFIP

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 1310L

FIRM
FLOOD INSURANCE RATE MAP
MARICOPA COUNTY,
ARIZONA
AND INCORPORATED AREAS

PANEL 1310 OF 4425
(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:	COMMUNITY	NUMBER	PANEL	SUFFIX
MARICOPA COUNTY	040037	1310	L	
PHOENIX, CITY OF	040051	1310	L	
SCOTTSDALE, CITY OF	045012	1310	L	

Notice to User: The Map Number shown below should be used when placing map orders; the Community Number shown above should be used on insurance applications for the subject community.



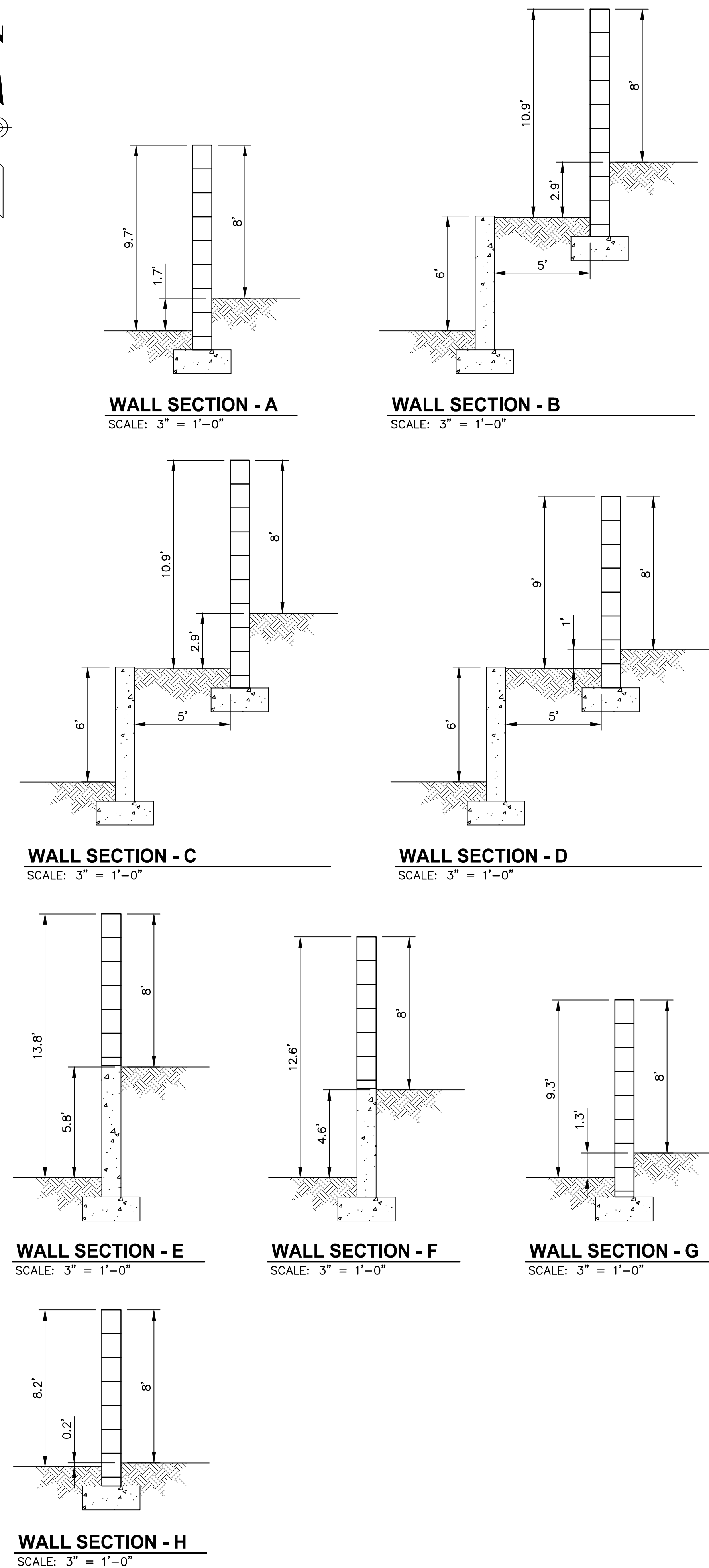
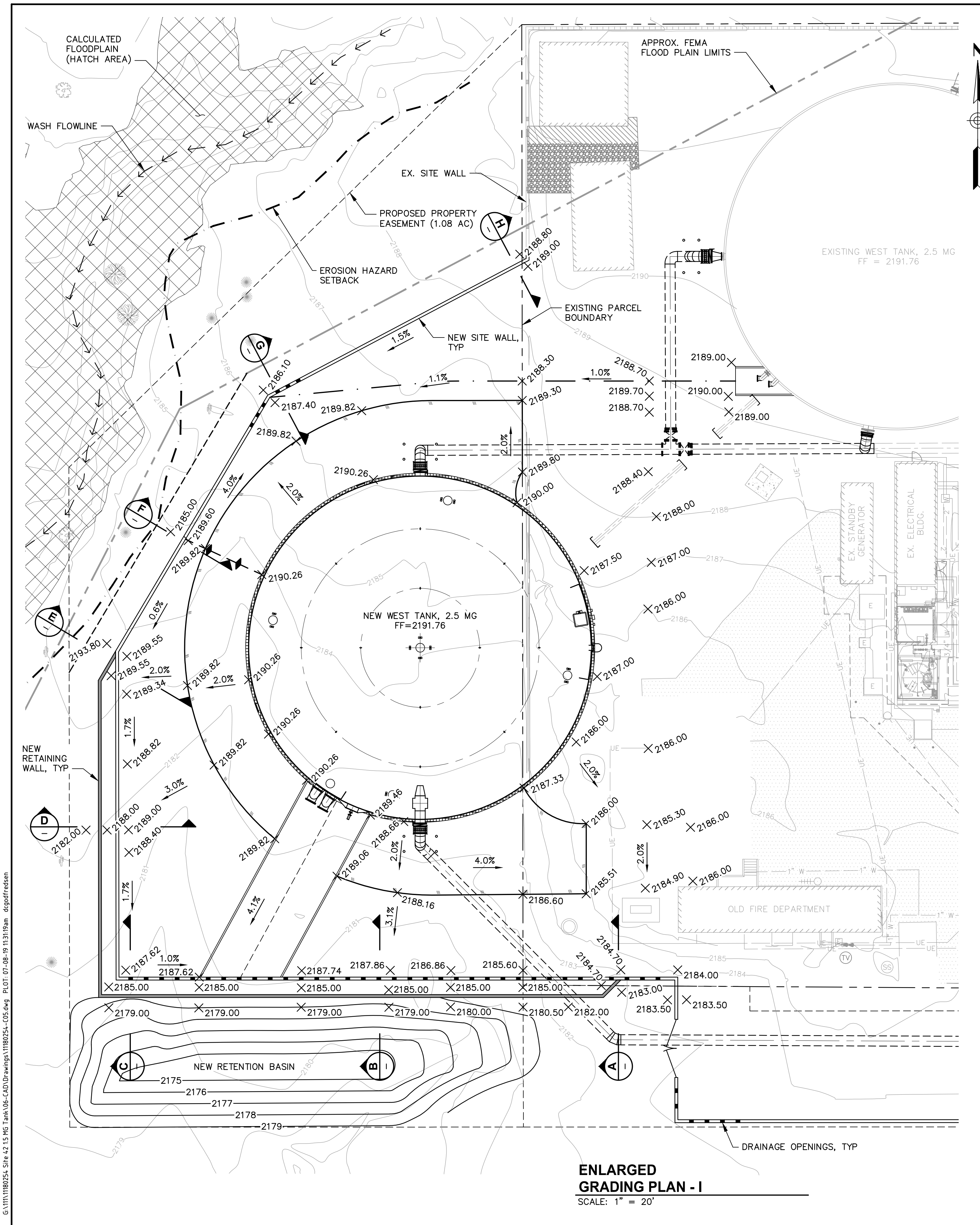
Federal Emergency Management Agency

MAP NUMBER
04013C1310L
MAP REVISED
OCTOBER 16, 2013



Appendix C

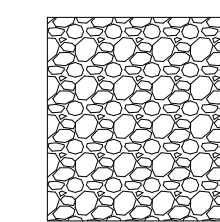
Site 42 Proposed Grading Plan



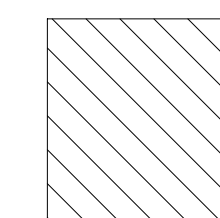
GHD Inc.
4747 North 22nd Street Suite 200
Phoenix Arizona 85016 USA
T 1 602 216 7200 F 1 602 216 7201 W www.ghd.com

GRADING NOTES

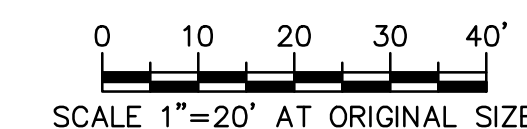
1. GRADES SHOWN AROUND PERIMETER OF RESERVOIRS REPRESENT FINISHED GRADE ADJACENT TO RETAINING RING.
2. BOLD ELEVATIONS REPRESENT FINISHED GRADE.
3. APPLY SOILTAC SOIL STABILIZER FOR HEAVY VEHICLE TRAFFIC WITHIN LIMITS OF DISTURBANCE SHOWN USING PROCEDURE OUTLINED BELOW.
4. TEST SOILS AND PROVIDE DATA TO STABILIZER MANUFACTURER TO DETERMINE DILUTION RATE, APPLICATION RATE, AND MIN. SCARIFICATION DEPTH.
5. CONFIRM SOIL HAS ACCEPTABLE SOIL MOISTURE CONTENT ON DAY OF STABILIZER APPLICATION.
6. SCARIFY TO STABILIZER MANUFACTURER'S RECOMMENDED DEPTH AND REMOVE AGGREGATE LARGER THAN 4".
7. APPLY STABILIZER AT MANUFACTURER'S RECOMMENDED RATE.
8. TILL OR DISC TREAT SOIL UNTIL UNIFORM STABILIZER DISTRIBUTION IS ACHIEVED.
9. PERFORM GRADING AFTER STABILIZER MIXING PER FINISHED GRADES SHOWN.
10. COMPACT GRADING TO 95% USING PNEUMATIC COMPACTOR FOR INITIAL COMPACTION AND VIBRATORY SMOOTH STEEL DRUM FOR FINAL COMPACTION.
11. RIP—RAP GRADATION AND THICKNESS:



SIEVE SIZE	PERCENT PASSING
6 INCH	90 – 100
4.24 INCH	70 – 85
3 INCH	30 – 50
2 INCH	5 – 15
1 INCH	0 – 5

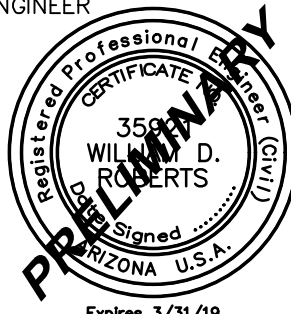



SIEVE SIZE	PERCENT PASSING
12 INCH	90 – 100
9 INCH	70 – 85
6 INCH	30 – 50
4 INCH	5 – 15
2 INCH	0 – 5



**30% SUBMITTAL
FOR AGENCY
REVIEW ONLY**



DATE		REVISION		BY	
ENGINEER		  <p>PUBLIC WORKS WATER RESOURCES DEPARTMENT</p> <p>9388 E. SAN SALVADOR DR. SCOTTSDALE, AZ 85268</p>			
SHEET TITLE					
PROJECT TITLE		<p align="center">GRADING PLAN I</p> <p align="center">SITE 42</p> <p align="center">2.5 MG RESERVOIR</p>			
SCALE	DESIGNED	DATE	BID NO.	SHT.	
HORIZ. AS	WDR	JUNE 2019		C5	
VERT. NOTED	DRAWN	AS-BUILT	PROJECT NO.	8 OF XX	
	DGC		WEQ2A		



Appendix D

Site 42 Precipitation Depths from NOAA Website



NOAA Atlas 14, Volume 1, Version 5
Location name: Scottsdale, Arizona, USA*
Latitude: 33.7291°, Longitude: -111.8935°
Elevation: 2190.78 ft**

* source: ESRI Maps

** source: USGS



POINT PRECIPITATION FREQUENCY ESTIMATES

Sanja Perica, Sarah Dietz, Sarah Heim, Lillian Hiner, Kazungu Maitaria, Deborah Martin, Sandra Pavlovic, Ishani Roy, Carl Trypaluk, Dale Unruh, Fenglin Yan, Michael Yekta, Tan Zhao, Geoffrey Bonnin, Daniel Brewer, Li-Chuan Chen, Tye Parzybok, John Yarchoan

NOAA, National Weather Service, Silver Spring, Maryland

[PF_tabular](#) | [PF_graphical](#) | [Maps_&_aerials](#)

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)¹										
Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.221 (0.184-0.271)	0.288 (0.241-0.353)	0.388 (0.322-0.475)	0.465 (0.382-0.566)	0.566 (0.459-0.688)	0.644 (0.516-0.777)	0.723 (0.570-0.870)	0.802 (0.623-0.965)	0.908 (0.688-1.10)	0.991 (0.736-1.20)
10-min	0.336 (0.280-0.412)	0.438 (0.366-0.538)	0.591 (0.489-0.723)	0.707 (0.582-0.862)	0.862 (0.699-1.05)	0.980 (0.785-1.18)	1.10 (0.867-1.32)	1.22 (0.948-1.47)	1.38 (1.05-1.67)	1.51 (1.12-1.82)
15-min	0.417 (0.347-0.511)	0.543 (0.454-0.667)	0.733 (0.606-0.897)	0.877 (0.721-1.07)	1.07 (0.866-1.30)	1.22 (0.973-1.47)	1.36 (1.08-1.64)	1.51 (1.18-1.82)	1.71 (1.30-2.07)	1.87 (1.39-2.26)
30-min	0.561 (0.467-0.688)	0.731 (0.611-0.898)	0.987 (0.816-1.21)	1.18 (0.972-1.44)	1.44 (1.17-1.75)	1.64 (1.31-1.98)	1.84 (1.45-2.21)	2.04 (1.58-2.45)	2.31 (1.75-2.78)	2.52 (1.87-3.05)
60-min	0.694 (0.578-0.852)	0.905 (0.757-1.11)	1.22 (1.01-1.49)	1.46 (1.20-1.78)	1.78 (1.44-2.16)	2.03 (1.62-2.44)	2.27 (1.79-2.74)	2.52 (1.96-3.04)	2.86 (2.16-3.44)	3.12 (2.31-3.77)
2-hr	0.807 (0.680-0.968)	1.04 (0.880-1.25)	1.38 (1.16-1.66)	1.65 (1.37-1.97)	2.00 (1.65-2.39)	2.27 (1.85-2.70)	2.55 (2.04-3.03)	2.83 (2.23-3.36)	3.21 (2.47-3.81)	3.51 (2.65-4.18)
3-hr	0.869 (0.732-1.06)	1.11 (0.941-1.36)	1.45 (1.22-1.77)	1.72 (1.43-2.08)	2.10 (1.72-2.52)	2.39 (1.94-2.87)	2.70 (2.15-3.23)	3.03 (2.37-3.61)	3.47 (2.64-4.14)	3.83 (2.85-4.58)
6-hr	1.04 (0.897-1.22)	1.31 (1.13-1.55)	1.67 (1.43-1.96)	1.95 (1.66-2.28)	2.34 (1.97-2.73)	2.65 (2.19-3.07)	2.96 (2.42-3.44)	3.29 (2.64-3.82)	3.72 (2.92-4.33)	4.06 (3.11-4.73)
12-hr	1.22 (1.06-1.42)	1.54 (1.33-1.79)	1.93 (1.67-2.25)	2.25 (1.93-2.61)	2.67 (2.27-3.09)	3.00 (2.52-3.46)	3.33 (2.76-3.85)	3.67 (3.01-4.24)	4.12 (3.29-4.78)	4.46 (3.51-5.21)
24-hr	1.45 (1.27-1.66)	1.84 (1.62-2.12)	2.39 (2.10-2.75)	2.84 (2.47-3.26)	3.46 (2.99-3.97)	3.97 (3.39-4.55)	4.50 (3.79-5.19)	5.06 (4.20-5.87)	5.85 (4.75-6.84)	6.49 (5.18-7.66)
2-day	1.62 (1.42-1.87)	2.07 (1.81-2.39)	2.73 (2.37-3.13)	3.26 (2.82-3.73)	4.01 (3.44-4.59)	4.61 (3.91-5.29)	5.25 (4.40-6.05)	5.92 (4.90-6.88)	6.86 (5.57-8.04)	7.63 (6.09-9.03)
3-day	1.73 (1.52-1.99)	2.22 (1.94-2.54)	2.94 (2.57-3.36)	3.53 (3.07-4.02)	4.37 (3.77-4.99)	5.06 (4.32-5.79)	5.79 (4.89-6.67)	6.58 (5.47-7.64)	7.70 (6.28-9.02)	8.62 (6.90-10.2)
4-day	1.84 (1.62-2.10)	2.36 (2.08-2.69)	3.15 (2.77-3.58)	3.80 (3.32-4.31)	4.74 (4.10-5.39)	5.51 (4.72-6.29)	6.34 (5.37-7.29)	7.24 (6.05-8.40)	8.54 (6.98-10.0)	9.62 (7.72-11.4)
7-day	2.11 (1.85-2.42)	2.71 (2.37-3.10)	3.62 (3.16-4.14)	4.37 (3.80-5.00)	5.47 (4.70-6.25)	6.37 (5.42-7.32)	7.36 (6.18-8.50)	8.43 (6.98-9.83)	9.97 (8.09-11.8)	11.3 (8.96-13.4)
10-day	2.31 (2.03-2.64)	2.96 (2.60-3.39)	3.95 (3.46-4.51)	4.76 (4.14-5.43)	5.93 (5.12-6.77)	6.89 (5.89-7.89)	7.94 (6.69-9.14)	9.06 (7.54-10.5)	10.7 (8.69-12.6)	12.0 (9.60-14.3)
20-day	2.92 (2.57-3.33)	3.76 (3.31-4.28)	4.99 (4.38-5.67)	5.95 (5.20-6.76)	7.28 (6.31-8.29)	8.33 (7.17-9.51)	9.43 (8.04-10.8)	10.6 (8.92-12.3)	12.2 (10.1-14.3)	13.4 (11.0-15.9)
30-day	3.46 (3.04-3.94)	4.46 (3.92-5.07)	5.91 (5.18-6.71)	7.04 (6.15-7.97)	8.58 (7.44-9.74)	9.79 (8.43-11.1)	11.0 (9.43-12.6)	12.3 (10.4-14.2)	14.1 (11.8-16.4)	15.5 (12.8-18.2)
45-day	4.10 (3.62-4.66)	5.29 (4.67-6.01)	7.02 (6.18-7.95)	8.34 (7.31-9.45)	10.1 (8.81-11.5)	11.5 (9.95-13.1)	13.0 (11.1-14.8)	14.5 (12.3-16.7)	16.5 (13.8-19.3)	18.1 (14.9-21.4)
60-day	4.58 (4.05-5.19)	5.93 (5.24-6.70)	7.83 (6.91-8.85)	9.26 (8.13-10.5)	11.2 (9.74-12.6)	12.6 (10.9-14.3)	14.1 (12.1-16.1)	15.6 (13.3-18.0)	17.7 (14.9-20.6)	19.3 (16.0-22.7)

¹ Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

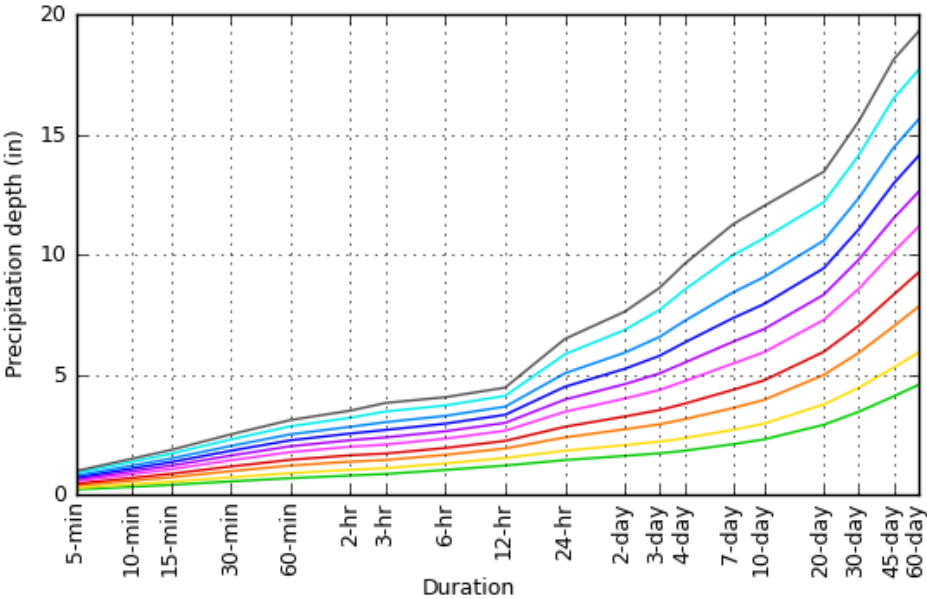
Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

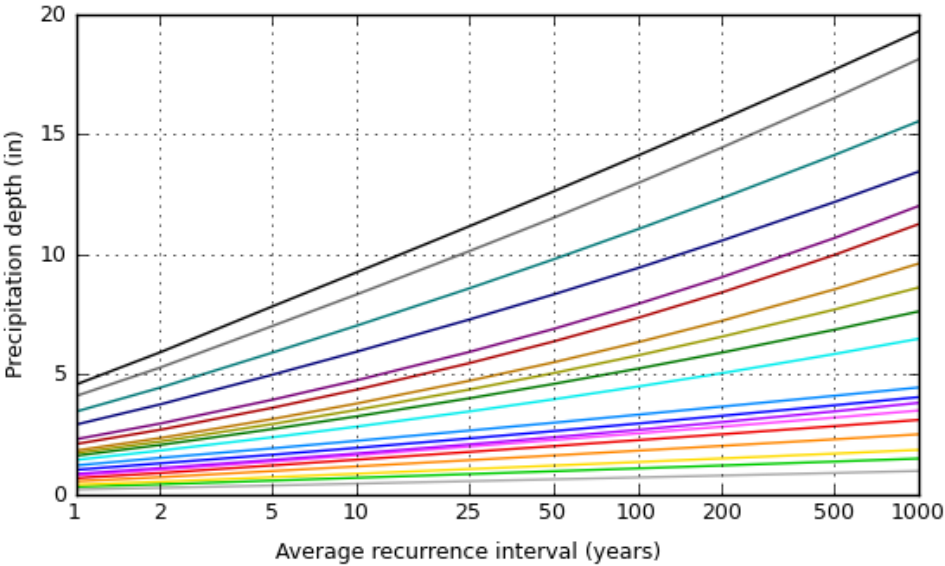
[Back to Top](#)

PF graphical

PDS-based depth-duration-frequency (DDF) curves
Latitude: 33.7291°, Longitude: -111.8935°



Average recurrence interval (years)	
1	
2	
5	
10	
25	
50	
100	
200	
500	
1000	

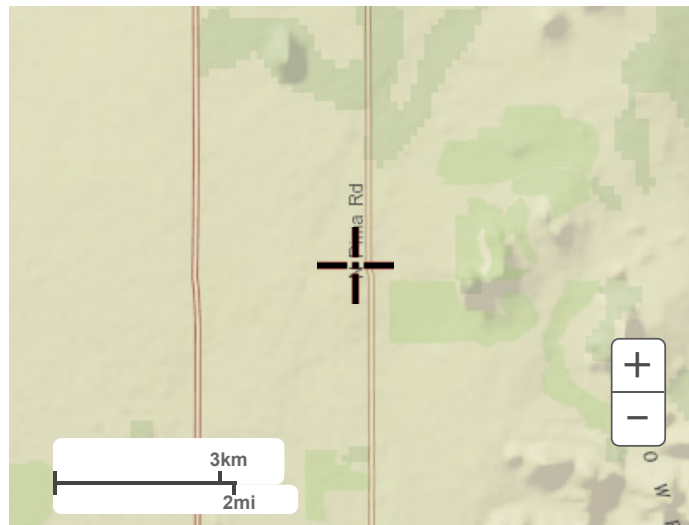


Duration	
5-min	2-day
10-min	3-day
15-min	4-day
30-min	7-day
60-min	10-day
2-hr	20-day
3-hr	30-day
6-hr	45-day
12-hr	60-day
24-hr	

[Back to Top](#)

Maps & aerials

Small scale terrain



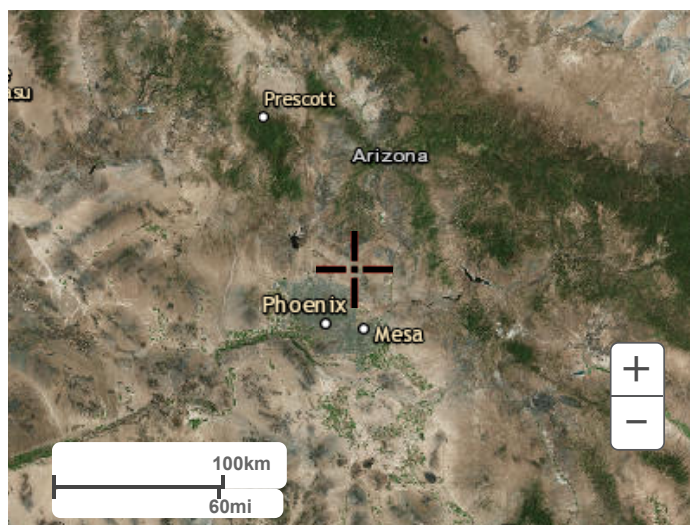
Large scale terrain



Large scale map



Large scale aerial



[Back to Top](#)

[US Department of Commerce](#)
[National Oceanic and Atmospheric Administration](#)
[National Weather Service](#)
[National Water Center](#)
1325 East West Highway
Silver Spring, MD 20910
Questions?: HDSC.Questions@noaa.gov

[Disclaimer](#)



about GHD

GHD is one of the world's leading professional services companies operating in the global markets of water, energy and resources, environment, property and buildings, and transportation. We provide engineering, environmental, and construction services to private and public sector clients.

Karl Tobin

Karl.Tobin@ghd.com
602.216.7236

Seth Morales

Seth.Morales@ghd.com
602.216.7212

www.ghd.com